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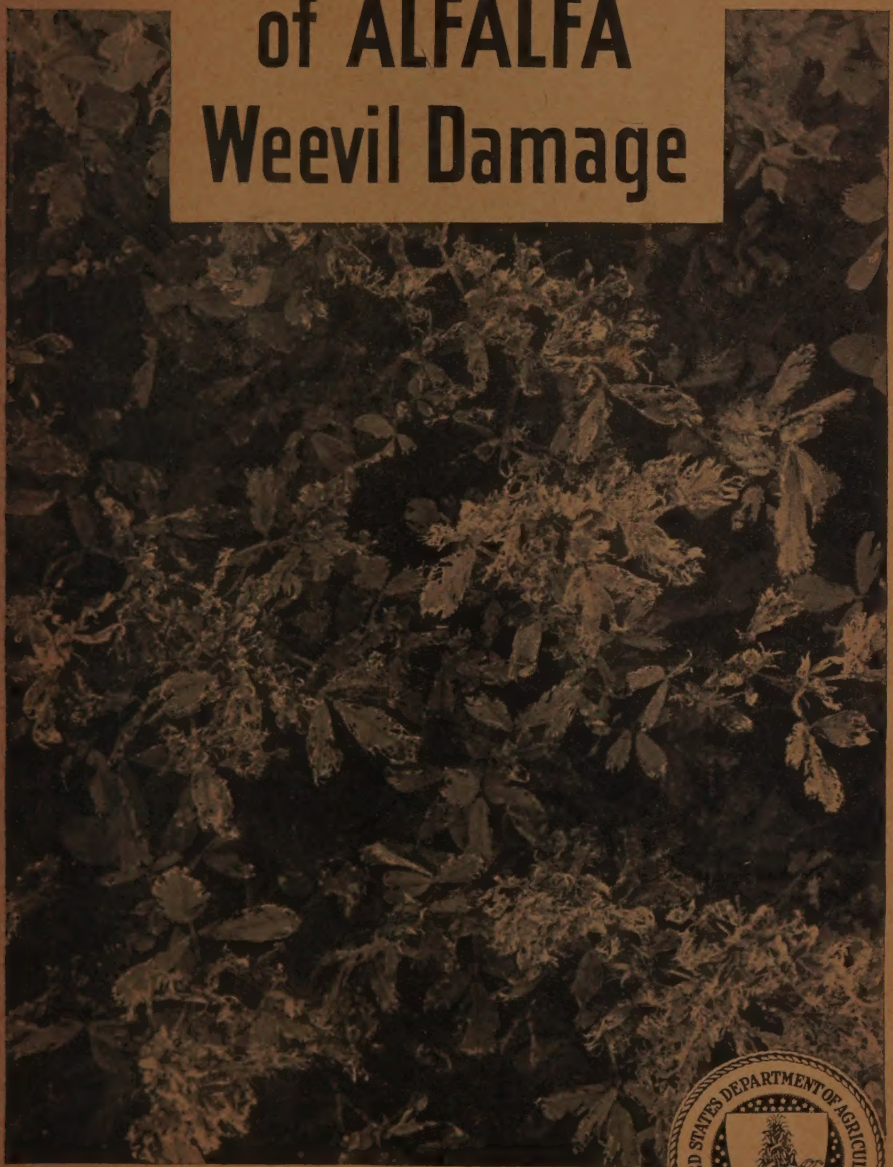
Prevention and Control of ALFALFA Weevil Damage



FARMERS' BULLETIN No. 1930
1943

THE ALFALFA WEEVIL has a history of causing severe damage to the alfalfa crop in the region between the Sierra Nevada and Rocky Mountain Ranges and in southwestern Oregon. The damage is now largely restricted to the spring growth of alfalfa and may usually be controlled by adjustment of cultural practices.

Early cutting is usually the most profitable method of preventing alfalfa weevil damage. Early cutting means harvesting when most of the alfalfa plants are in the flower-bud stage of growth. Early cutting of the first crop also prevents retardation of the second growth by the larvae, which are left without shelter or food because the young shoots have not then appeared at the crowns.

Early cutting of the second crop is also necessary, not to prevent crop damage, but to hold down the number of adult weevils that will generate the attack against the next year's spring growth of alfalfa.

Early cutting of alfalfa is not recommended in areas where this weevil is not a pest.

If weevil damage develops before the first alfalfa growth reaches the flower-bud stage, it may be controlled by dusting or spraying with calcium arsenate at the rate of 2 pounds per acre.

Fields of thin stand or poor growth are less thoroughly shaded, and the consequent higher temperatures accelerate egg laying and hatching and the development of weevil larvae, permitting them to become destructive before the alfalfa produces flower buds. Maintenance of a thick, vigorously growing stand of alfalfa is the basic step in control of the alfalfa weevil.

This bulletin supersedes Farmers' Bulletin 1528, The Control of the Alfalfa Weevil.

Washington, D. C. Issued April 1943

PREVENTION AND CONTROL OF ALFALFA WEEVIL DAMAGE

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ECONOMIC HISTORY OF THE ALFALFA WEEVIL IN THE UNITED STATES

THE ALFALFA WEEVIL[1] is an Old-World insect that appeared near Salt Lake City, Utah, in 1904 and now occurs in 11 Western States (fig. 1). Economic damage has been confined to alfalfa and has been restricted almost entirely to Utah, Nevada, Idaho, Colorado, and Oregon, where the weevil is the major insect pest of alfalfa and frequently causes important losses. This area lies within the western range region, in which alfalfa is an essential factor in the support of a great livestock industry. Hence prevention or control of losses from alfalfa weevil attack is valuable to stockmen as well as to alfalfa growers of the Great Basin region.

Early research by the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture resulted in the importation and establishment in weevil-infested areas of an insect parasite

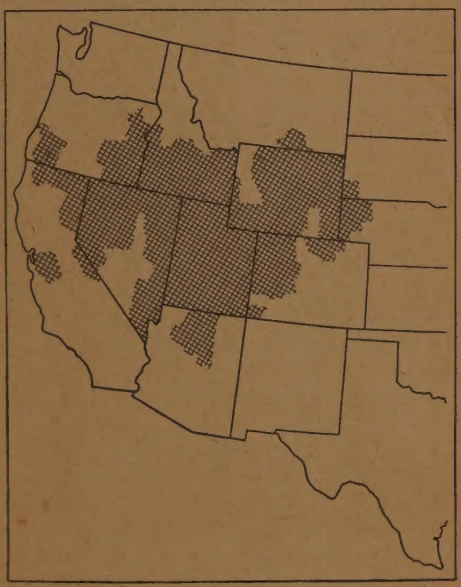

FIGURE 1.—Distribution of the alfalfa weevil in the United States. The shaded area includes the counties in which the alfalfa weevil had been found to January 1940.

[1] *Hypera postica* Gyll.; order Coleoptera, family Curculionidae.

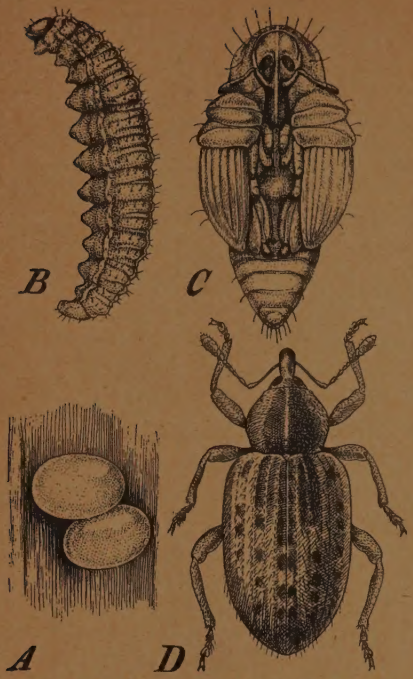

FIGURE 2.—Stages of the alfalfa weevil: *A*, eggs; *B*, the larva; *C*, the pupa; *D*, the adult weevil. *A* about 24 times, *B* 5 times, *C* 8 times, and *D* 8 times natural size.

of the weevil and in the development of direct control by spraying or dusting alfalfa with calcium arsenate. More recent research has shown that in most seasons in nearly all weevil-infested areas the weevil may be controlled by cultural methods. This method of control is especially profitable because it is a preventive measure and is effected by regular harvesting operations. Successful cultural control, however, requires a knowledge of weevil development in relation to the weather, the parasite, and the culture, growth, and harvest of the alfalfa hay crop. This subject and related information on alfalfa weevil control are discussed in this bulletin.

STAGES OF THE WEEVIL

The adult alfalfa weevil (figs. 2, *D*, and 3) is a snout beetle about three-sixteenths of an inch long, varying in color from brown to black. Newly emerged weevils are brown, with a broad darker brown stripe extending backward from the front of the head more than half the over-all length of the insect. With increasing age the coating of brown scales wears off and the weevils become almost uniformly black.

The eggs (fig. 2, *A*) are oval, about one-fiftieth of an inch long, and lemon yellow when fresh, becoming paler yellow with age and finally dark as the young larvae develop inside and hatching time approaches. They are laid in clusters (fig. 4) of from 2 to 25 or more, inside hollow stems of alfalfa, grass, or weeds. The early eggs are deposited in litter lying on the surface of the soil, but later the growing alfalfa stems are chosen, and nearly half of the seasonal total may occur in them, particularly near the base of the stalks. Thus approximately three-fourths of all weevil eggs are laid within 3 to 4 inches of the soil surface.

FIGURE 3.—The adult weevil on alfalfa. About twice natural size.

The larva (fig. 2, *B*) is the stage of the weevil most familiar to alfalfa growers in infested areas. When it hatches it is one-twentieth inch long and is yellow, except for the shining-black head. It molts three times and grows to three-eighths inch in length at maturity, when the head is brown and the body is green with a white stripe along the middle of the back, paralleled by another fainter stripe along each side. Upon completion of feeding, the weevil larva spins a white, oval, netlike cocoon (fig. 5), about one-fourth inch long, in which transformation to the pupa, or resting stage (fig. 2, *C*), occurs after several days. The cocoons are generally spun near the base of alfalfa plants, favored situations being within the curl of fallen dead leaves or in the other litter among the crowns. From the pupa, which is green, the adult weevil emerges after 1 to 2 weeks and spends a day or two in the cocoon before leaving it.

FIGURE 4.—Alfalfa stalk split to show a cluster of eggs of the alfalfa weevil.

SEASONAL HISTORY

Alfalfa weevil adults are produced during the summer, some from larvae that develop on the first alfalfa crop and others from larvae that live on the second crop. In haying operations many adults are carried to haystacks, but few of these survive. Numerous weevils migrate in summer to ditchbanks and field borders, where they spend the winter. They do not develop sexually until the following spring, when they leave the waste areas. The movement of weevils out of fields in the summer and from haystacks and waste areas in the spring contributes to the infestation of new plantings of alfalfa and the local spread of the insect.

Most of the weevils remain in alfalfa fields, however, and in the fall some of the females develop mature eggs, mate, and begin laying. The proportion of female weevils capable of laying before winter begins varies with the season and the area, but in the Great Basin it generally ranges from 2 to 28 percent. The weevils remain active as long as temperature is favorable, but only a few eggs are laid before cold weather sets in and all weevil activity is stopped. In the lower valleys of western Colorado, however, where the fall season is longer, from two-thirds to three-fourths of the female weevils deposit considerable numbers of eggs during fall. The fall-laid eggs do not hatch until the following spring, and the alfalfa weevil overwinters chiefly as an adult in or near alfalfa fields.

FIGURE 5.—Cocoons of the alfalfa weevil on leaves; the white bands of cocoons of the parasite *Bathyplectes curculionis* are visible inside the two weevil cocoons marked with arrows.

Adult weevils resume activity and egg laying begins with the first spring warmth. Egg laying proceeds best when the temperature at crown level in alfalfa fields rises above 50° F. during the day and falls below that at night. These conditions are not those most favorable to hatching, and in consequence large numbers of eggs accumulate. As the season advances, temperatures favorable to hatching occur and immense numbers of weevil larvae are loosed rapidly upon the alfalfa crop. Egg laying and hatching continue after the hatching of the accumulated eggs, thus increasing the larval population. The timing of egg laying and hatching and of larval development with reference to the growth and maturity of the first alfalfa crop varies in different seasons and areas. In general, however, egg laying is largely completed, most of the larvae are still immature, and cocooning has barely started when the spring growth of alfalfa reaches the flower-bud stage of maturity—usually late in May or early in June in the lower valleys and from 2 to 3 weeks later in higher valleys of the Great Basin. Harvest of the first crop at such a time destroys nearly all the immature stages of the weevil in favorable haying weather, and few adult weevils of the new generation are produced. These adults are important only in increasing the number of weevils that may survive the following winter.

By the time of the first harvest most of the overwintered adult weevils have died, and the few remaining females have almost exhausted their egg-laying capacity. Consequently few eggs are laid during the growth of the second alfalfa crop. These eggs produce larvae, but in most of the weevil-infested areas they are much too scarce to cause damage, or even to be noticed. Nevertheless, they may furnish the greater part of the new generation of adult weevils which will live over winter and generate the attack against the spring growth of alfalfa the following year.

WEEVIL DAMAGE

The alfalfa weevil feeds only on legumes. Alfalfa is definitely preferred, and the economic importance of the weevil in the United States rests solely upon its injury to this crop.

Practically all damage now caused by the alfalfa weevil falls upon the first, or spring, growth of alfalfa. The injury (fig. 6) results from the feeding of the larvae. The tiny larvae feed within the growing plant tips, and the larger ones feed increasingly on the upper opened leaves, from which they devour the green tissues, leaving only the leaf veins and lower epidermis. Damaged leaves dry rapidly and take on a grayish to whitish cast, giving damaged fields (fig. 7) the appearance of having been frosted. This appearance is characteristic of economic damage, and as the larvae increase in size and number they injure more and more of the lower foliage. Small areas of leaf surface not actually consumed also dry out, and the leaves thus skeletonized make poor-quality hay. These feeding habits are especially destructive, since approximately two-thirds of the food value of alfalfa hay is in the leaves.

FIGURE 6.—Terminal leaves skeletonized by larvae of the alfalfa weevil.

Backward spring weather, which favors even greater accumulation of eggs in the field than usual, is followed in some years by a sudden change to seasonal temperatures, with the result that great numbers of larvae hatch almost simultaneously. Since the alfalfa has continued to grow during the cool weather, these larvae may attack the crop when it is nearly ready to cut. In this case the tiny larvae produce a characteristic effect upon the plants. Instead of the grayish cast appearing generally over the upper several inches of the alfalfa plants, the injury is confined largely to the growing tips, giving them a frazzled appearance and stopping growth, although there is no large amount of injury to the leaves as in more typical weevil damage. When cutting is delayed, the injury tends toward the usual type.

Few instances of retardation of the second crop have been observed in recent years, and all were associated with belated harvest of the first crop. In such cases the second-crop shoots had already appeared, and the larvae that had been living on the first growth transferred their feeding to the young shoots.

In southwestern Oregon light to moderate weevil injury was reported as affecting the maturing second growth shortly after the weevil appeared there. Similar injury has been known to occur in alfalfa-seed districts, where an advanced second growth is managed for seed production after the first growth has been grazed off with sheep or cut early.

FIGURE 7.—Alfalfa field showing upper leaves grayed by the feeding of alfalfa weevil larvae, before the damage reached the lower foliage.

THE IMPORTED PARASITE

The imported parasite *Bathyplectes curculionis* (Thoms.) is immensely valuable to alfalfa growers in the weevil-infested States because during most seasons, in nearly all areas, it makes possible cultural control of the weevil. The parasite, however, does not control the weevil unaided, and an understanding of how it works is necessary in order to utilize its benefits.

The adult female parasite (fig. 8) inserts her egg directly into the body of the weevil larva. The victim is not immediately killed but continues to feed and, although consuming about one-third less than an unparasitized weevil larva, completes its development and spins its cocoon. During this period the parasite egg hatches into a maggotlike larva, which develops in the body fluids of the victim until after the latter has spun its cocoon, when the parasite larva ma-

tures, destroys the weevil larva, and immediately spins its own cocoon inside the weevil's cocoon (fig. 5). The parasite cocoon (fig. 9) is cylindrical, with the ends bluntly rounded, about one-eighth inch long, and brown with a white band around its middle. The delicate cocoons of the weevil soon disintegrate, and the parasite cocoons are freed upon the surface of the field. The parasites live as larvae in the cocoons until early in the following year, when the adults emerge while the weevil larvae are attacking the spring growth of alfalfa.

FIGURE 8.—Adult female of the imported parasite *Bathyplectes curculionis;* at right, lateral view of its abdomen. About 16 times natural size.

The earliest weevil larvae are almost all parasitized and perish before developing to adult weevils. But by the time the accumulated weevil eggs have hatched and the larvae occur in great numbers the parasite is unable to multiply commensurately, with the result that the number of maturing weevil larvae escaping the parasite gradually increases. In most areas, however, from 80 to 90 or more of each 100 maturing weevil larvae contain parasites when the first alfalfa crop reaches the flower-bud stage of growth. The second-crop basal shoots have not then appeared, and, if the crop is harvested at that time, all the smaller larvae, as well as some of the unparasitized ones approaching maturity, are killed by starvation or heat in the bare stubblefield. Cocooning of the weevil has just begun at this time,

and the cocoons present are those spun by the earliest larvae, nearly all of which are prevented by the parasite from producing adult weevils. The few cocooned individuals that escape the parasite are mostly killed by exposure to heat in the stubblefield.

Cutting the first crop of alfalfa at the flower-bud stage therefore holds to very low levels the first portion of the new generation of adult weevils that will go into hibernation with the coming of winter. Such harvesting also usually takes place before severe damage has occurred to the first crop of alfalfa. The longer harvesting is delayed beyond the flower-bud stage, the greater will be the number of unparasitized weevil larvae that spin their cocoons, pupate, and emerge as adults. In the adult stage they may seek shelter beneath alfalfa crowns and in soil cracks, where they survive the stubblefield heat. Delayed harvest also results in very rapid increase of crop damage in fields having injurious numbers of weevils.

FIGURE 9.—Cocoons of the imported parasite *Bathyplectes curculionis*. About 4 times natural size.

The few weevil larvae living on the second crop are not effectively parasitized, and for this reason they may produce more adult weevils of the new generation than do the hordes of larvae that feed on the first crop. Consequently, from the viewpoint of the succeeding year's weevil problem, these larvae are fully as important as the damaging first-crop larvae.

The foregoing discussion shows that supplemental measures must be taken to help the parasite control the weevil.

CONTROL MEASURES

EARLY CUTTING

Early cutting of the first and second alfalfa crops usually provides the most practical method of control. Early cutting means harvesting when the majority of alfalfa plants are in the flower-bud stage of growth, at which time there is only a sprinkling of blooms and only the earliest shoots of the second growth are appearing at the crowns. Clean cutting at this time and prompt removal of the hay leave the weevil larvae on the bare fields, where nearly all of them, together with eggs and pupae, die of starvation or exposure to heat.

Consequently, when the second-crop shoots appear in profusion they grow unhindered. Comparatively few adult weevils of the new generation will therefore be produced to carry the species over winter. Early cutting of the second crop, 35 to 40 days after the first harvest, will rarely be necessary to prevent material injury, but is essential in order to restrict the number of weevils of the new generation. Early cutting of the first and second crops of alfalfa should be practiced every year, even though these crops are not actually being injured; if this practice is not followed, enough weevils may be produced to cause damage the following year.

In areas where the alfalfa weevil does not occur or never becomes a serious pest the early cuttings recommended as a means of preventing damage by this insect are not advisable.

Early cut alfalfa is more leafy and, pound for pound, has more food value than hay cut later. Hay cut at a later stage of growth has a greater proportion of stems, and any increase in tonnage gained by delayed cutting thus consists largely of fibrous, indigestible material. Moreover, if weevil damage develops, it reduces the leaf content of the hay, and the loss is magnified because the leaves contain most of the beef- and milk-producing values of alfalfa hay.

Continuous early cutting may thin out alfalfa stands more rapidly than cutting at a more advanced stage of development. In areas harvesting three crops yearly, however, the third crop should be allowed to develop to full bloom before harvest in order to promote growth of the roots and storage of food in them. In some areas where, as a rule, two crops are harvested at full bloom, three crops may be harvested in most seasons if early cutting is practiced. In other areas, where only two crops can be cut during the season, the choice must be between taking a chance on the more rapid thinning of the stand and suffering damage by the alfalfa weevil. When such damage occurs, however, it can be controlled by dusting or spraying, as outlined under the heading Dusting and Spraying, page 10.

In brief, then, the following practices are recommended for obtaining the best results from early cutting:

1. Cut the alfalfa in the flower-bud stage.
2. Mow the field clean and close, leaving it as bare of food as possible, so as to starve immature weevil larvae.
3. Remove the hay promptly after it is cured, so as to expose the clean stubblefield to the greatest amount of sunshine and heat.
4. Keep the field surface as dry as possible for 1 week before cutting and for 7 to 10 days thereafter.
5. Practice early cutting every year, regardless of weevil injury.

Control by early cutting is not always practicable. Weevil damage occasionally develops while the first crop is too immature for harvest, and in a few areas, notably the lower valleys of western Colorado, this is the rule. Even when the alfalfa crop reaches the flower-bud stage before serious weevil injury develops, unfavorable haying weather may prevent early cutting. A number of other conditions of practical farming may prevent control by early cutting. Regular or occasional shortage of irrigation water late in the season may make it necessary to obtain the maximum tonnage, not the best quality, of hay from the first alfalfa growth because it becomes the only source of the next winter's feed supply. In certain areas, moreover, the alfalfa acreages

are so large that cutting is a continuous summer operation and timely cutting is not feasible. Nor can early cutting be practiced in fields managed for alfalfa-seed production, where either the first or second growth is allowed to stand until the seed matures. In all such cases where climatic conditions of an area, seasonal weather, or other factors make early cutting impracticable, resort must be had to control by dusting or spraying with insecticides when weevil damage threatens.

DUSTING AND SPRAYING

Dusting or spraying with calcium arsenate reduces the number of larvae and thus prevents further damage until the crop can be harvested. Either treatment requires the application of 2 pounds of calcium arsenate per acre. The two treatments are about equally effective, but since the dust may be applied more easily and quickly than the spray, dusting is usually preferred. Because of the physical properties of calcium arsenate, some difficulty may be experienced from uneven discharge of the insecticide from the duster, but this may be overcome by mixing the calcium arsenate with an equal quantity of dusting sulfur. The larger volume of this mixture also aids in spreading the small amount of calcium arsenate evenly. Ready mixed calcium arsenate and dusting sulfur, as required for alfalfa weevil control, is obtainable on the market. Either power or traction dusters, capable of covering 8 to 10 acres or more per hour, should be used on large acreages. Small hand dusters are more practical for small acreages. From 5 to 8 acres per day may be treated with a good hand duster.

Where spraying equipment is available, particularly in orchard districts, growers may prefer to apply the calcium arsenate in the form of a spray. An orchard sprayer may be used by adding a boom attachment, which can be made from half-inch iron pipe and self-cleaning spray nozzles. The calcium arsenate should be applied at the rate of 2 pounds, in 100 gallons of water, per acre. The addition of a spreader material to the spray does not appreciably increase its effectiveness. The spray mixture should be applied as a mist, under pressure of not less than 75 pounds.

If properly timed, one treatment of the first crop is usually all that is required. For maximum benefit, the plants should be dusted or sprayed as soon as the larvae have caused the upper leaves, though still green, to become noticeably ragged and before many of the plants have begun to show a grayish color. To make the treatment effective and to reduce the arsenical residue on the hay, the alfalfa should be allowed to grow at least a week or 10 days after the spraying or dusting before it is harvested. Treatment of the second crop as it approaches maturity is rarely necessary.

One difficulty with spraying or dusting is that the need for such treatment cannot be determined until the crop shows damage. While the treatment will prevent further damage, it does not restore the leaf surface already destroyed. For this reason early cutting should be viewed more in the light of preventive control, whereas insecticidal treatment is in the nature of emergency control.

The cost of dusting or spraying alfalfa varies with local prices but is estimated at $1. to $1.25 per acre.

ARSENICAL RESIDUE ON HAY

No authenticated case is known of livestock poisoning resulting from feeding alfalfa hay treated with calcium arsenate at the rate prescribed in this bulletin. G. I. Reeves, formerly of the Bureau of Entomology and Plant Quarantine, has reported that the arsenical content of sprayed hay, in terms of white arsenic, ranges from less than 1 grain to nearly 29 grains for 30 pounds of hay and is usually between 5 and 10 grains. The especially large quantity of 29 grains in one day's ration is within the limit of tolerance of horses and cattle.[2] The Utah Agricultural Experiment Station,[3] cooperating with the Bureau of Entomology and Plant Quarantine, conducted two series of feeding tests in which horses, cattle, and sheep were fed only alfalfa hay that had been dusted with 3 or 6 pounds of calcium arsenate per acre, and they concluded that alfalfa dusted with 2 pounds of calcium arsenate to the acre may be fed to livestock without injury for at least one feeding season of 4 to 6 months. Additional assurance as to the safety of using calcium arsenate on alfalfa hay crops as prescribed in this bulletin is provided by the fact that a considerable acreage has been so treated during the last 20 years without any ill effects on livestock.

STUBBLE TREATMENT

Retardation of the second growth of alfalfa rarely occurs under present-day harvesting practices. However, if failure to practice early cutting is followed by severe damage to the first crop and this has not been controlled by dusting or spraying, it may become necessary to attempt the destruction of larvae that are holding back the young second growth following the belated first harvest. Probably the best treatment under such circumstances is to keep the field dry and drag it thoroughly, using a spike-tooth harrow with the spikes enmeshed in a coarse netted wire or strung with a barbed-wire entanglement and the spikes tilted backward at an angle of 45°. This treatment has the two-fold effect of starving the larvae by destroying all young shoots and of dislodging, mashing, or otherwise injuring larvae and pupae and exposing them to the sun's heat. After the dragging, irrigation should be withheld for several days. This method is recommended only as a last resort, and cultivation to destroy young shoots is not recommended in the absence of weevils.

Dusting or spraying the stubble after cutting, to prevent retardation of the second crop, is not recommended.

ALFALFA CULTURE IN RELATION TO WEEVIL CONTROL

Alfalfa weevil control is largely an individual field problem. In spite of some migration of weevils, fields in which large numbers of weevils are produced during one season usually remain heavily infested the following season. Consequently weevil damage may be controlled by individual farmers, regardless of damaging infestations on nearby farms.

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[2] REEVES, G. I. THE ARSENICAL POISONING OF LIVESTOCK. Jour. Econ. Ent. 18: 83–89. 1925.

[3] FREDERICK, H. J. FEEDING VALUE OF ALFALFA HAY TREATED WITH CALCIUM ARSENATE. Utah Agr. Expt. Sta. Bul. 223, 8 pp., illus. 1930.

FIGURE 10.—A thick, vigorous stand of alfalfa, which shades the ground thoroughly in the spring and retards weevil development.

FIGURE 11.—A moderately thin stand of alfalfa, which permits the sun's heat to warm the field surface and accelerates weevil development.

The first step in controlling the alfalfa weevil is to maintain a dense stand in vigorous growing condition. It has been found that thin stands permit about 30 percent more heat to penetrate to ground level than do average stands. The effect is to accelerate egg laying and hatching and the growth of larvae and thus to increase the possibility that weevil damage may develop before the first alfalfa crop reaches the flower-bud stage. A similar effect results from poor growth of the alfalfa crop. The principal stand-thinning factors are bacterial wilt and the alfalfa stem nematode, while phosphorus deficiency and lack of humus in the soil are common causes of poor growth. Plowing out alfalfa stands after 4 to 5 years, rotating with grain and cultivated crops for a few years, and manuring the land not only result in the most profitable alfalfa culture but also minimize alfalfa weevil damage. Figure 10 shows the thoroughness of shading afforded in spring by a thick, vigorous stand of alfalfa in contrast with the condition in a moderately thin stand (fig. 11).

In some areas thin stands are intercropped with oats, rye, vetch, barley, grass, or various combinations of these to increase the hay tonnage and suppress weed growth. The chief objection to this practice is that the intercrop and the alfalfa do not mature simultaneously and growers tend to delay harvest until the intercrop is ready to be cut. By that time the alfalfa has become overmature and has suffered the full severity of weevil attack. In consequence the quality of the hay is lowered, weevil injury is increased because the larvae are concentrated upon a small quantity of alfalfa, and maximum numbers of adult weevils are produced for the following year. For these reasons intercropping, except in case of necessity, should not be practiced in districts infested by the alfalfa weevil. The better remedy for thin stands is to plow them out and, after rotation, to replace them with dense, vigorous alfalfa stands.

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